HERBICIDE TESTING

AT MT. SOPRIS TREE NURSERY

by

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TABLE OF CONTENTS

ABSTRACT

Tests conducted at Mt. Sopris Tree Nursery revealed several promising preemergence and contact herbicides. Modown, Devrinol and Amex-820 are new preemergence chemicals that produced no visible phytotoxicity on tree seedlings but had excellent weed control. Dacthal was the only currently registered preemergence herbicide that achieved comparable results. Post-seeding herbicide applications were the most effective type of application. Lorox and Modown exhibited potential as contact herbicides. Additional tests are required to determine proper application techniques of all these chemicals.

INTRODUCTION

Weed control has become increasingly difficult at Mt. Sopris Tree Nursery, which is operated by the USDA, Forest Service near Basalt, Colorado. Weed seed populations have become extremely high in nursery seedbeds because of the elimination of soil fumigation and the high cost of hand weeding. Although several herbicides have been used at the nursery, many weed species, especially common purslane (*Portulaca oleracea* L.), have apparently developed resistance to the chemicals. Many seedbeds were dominated by weed cover during the 1976 field season (Figure 1).

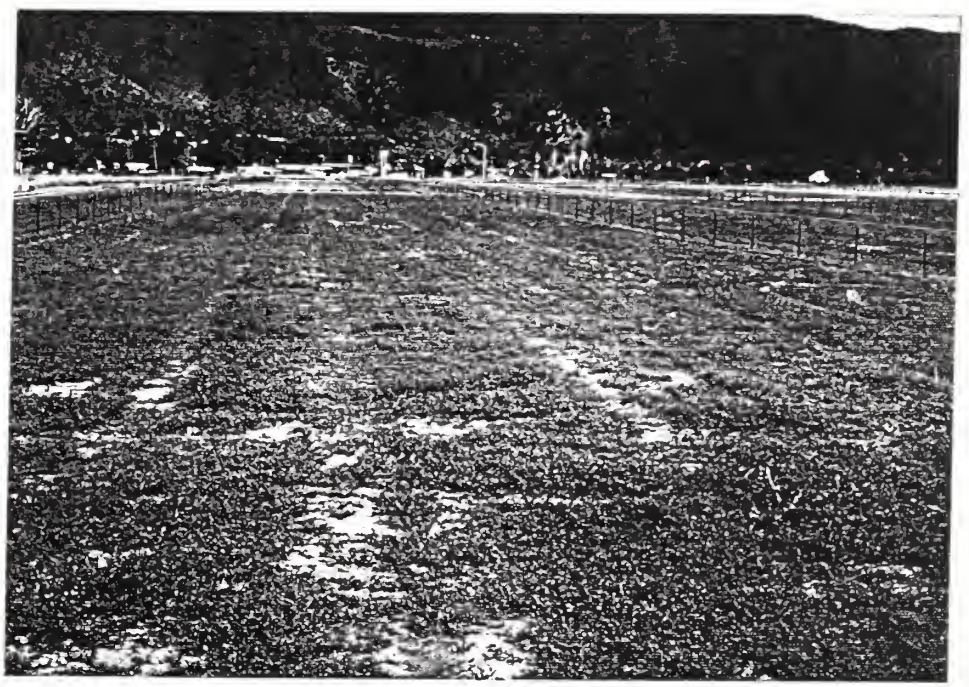

Figure 1 - Weeds overtopped young conifers in many seedbeds during the 1976 growing season at Mt. Sopris Nursery.

A westwide study was initiated in the spring of 1976 to investigate chemical herbicides currently registered for forest nursery use, as well as newly developed agricultural chemicals. 1/ In conjunction with this investigation, an administrative study at Mt. Sopris Tree Nursery was organized to test potentially useful herbicides. These tests involved preemergence herbicides, which are applied to the seedbed at sowing time to selectively kill weeds as they germinate without damaging the young tree seedlings.

The objectives of this portion of the study were to evaluate selected preemergence herbicides for possible phytotoxicity on tree seedlings as well as observe their efficiency in controlling weeds. The results of this preliminary study will be used for selecting the herbicides of the larger westwide study.

The second phase of the investigation was initiated early in the 1976 growing season in response to the large population of already established weeds in beds of older nursery stock. To combat these weeds, a series of field trials was designed to test several contact herbicides which kill weeds when applied to their foliage. The objective in this part of this study was to evaluate several promising contact herbicides for control of existing weeds without damaging the established tree seedlings.

METHODS AND MATERIALS

Preemergence herbicides

Seven chemicals were selected for the preemergence tests; four were herbicides currently registered for tree crops, and three were promising agricultural chemicals (Table 1). Application rates were based on manufacturers' recommendations and results of other field tests. All rates are given in actual pounds of chemical per acre of treated area.

Three different timings of herbicide application were used: 1) "pre-seeding incorporation" herbicides were mixed into the seedbed prior to sowing, 2) "post-seeding" chemicals were immediately applied to the surface of the sown seedbed, and 3) "post-emergence" treatments consisted of herbicide applications 4-6 weeks after emergence of the tree seedlings.

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[1]Stewart, R., S. McDonald and L. Abrahamson. 1976. An administrative study for herbicide screening and weed control demonstration in western forest tree nurseries. 1976-1980. USDA, Forest Service, Corvallis, Oregon, 22 pages.

Table 1 - Types, rates and timing of preemergence herbicides tested at Mt. Sopris Tree Nursery

Chemical	Formulation	Application Rate (Actual - lbs./acre)	Timing of Application and Treatment Number: Pre-Seeding Incorporation	Post-Seeding	Post-emergence	Totals
A. Currently Registered						
Diphenamid	Dymid 80 WP	4	1	2	3	3
Trifluralin	Treflan 4EC	0.75	4			1
DCPA	Dacthal WP-75	14		5	6	2
Cloramben	Ornamental Weeder G	4			7	1
						7
B. New Trials						
Butralin	Amex-820 4EC	2	8	9	10	3
Napropamide	Devrinol 50WP	3		11	12	2
Bifenox	Modown 2EC	1.50		13	14	2
						7
C. Control (Treatment #15)		-				1
					Total Treatments	15

Fifteen treatments resulted from the seven herbicides in various types of applications and one control (Table 1). All herbicides were applied according to the recommendations of the manufacturers.

All three major tree species raised at Mt. Sopris Tree Nursery were included in the herbicide tests: ponderosa pine (*Pinus ponderosa* Laws.), lodgepole pine (*P. contorta* var. *latifolia* Engelm.) and Engelmann spruce (*Picea engelmannii* Parry).

All herbicide treatments were applied to a rectangular area that extended across one seedbed of each tree species (Figure 2). This design was used so that (1) possible phytotoxic effects could be evaluated on seedlings of each tree species, and (2) a weed control rating could be established for each herbicide. The treatment area was approximately 3 feet wide by 17 feet long (51 $ft.^2$) including the paths between the seedbeds. Flag stakes were used to delineate the four corners, and a 1-foot wide buffer was allowed between treatments.

The preemergence herbicides were applied within one nursery unit which was chosen for homogeneity of site conditions and lack of other production problems. Individual treatments were randomly assigned in a linear pattern until all 15 treatments were established continuously (Figure 2). Three additional replications were made in like manner using new random numbers until all four replications were established linearly in one nursery unit, Unit 2 of Block 8.

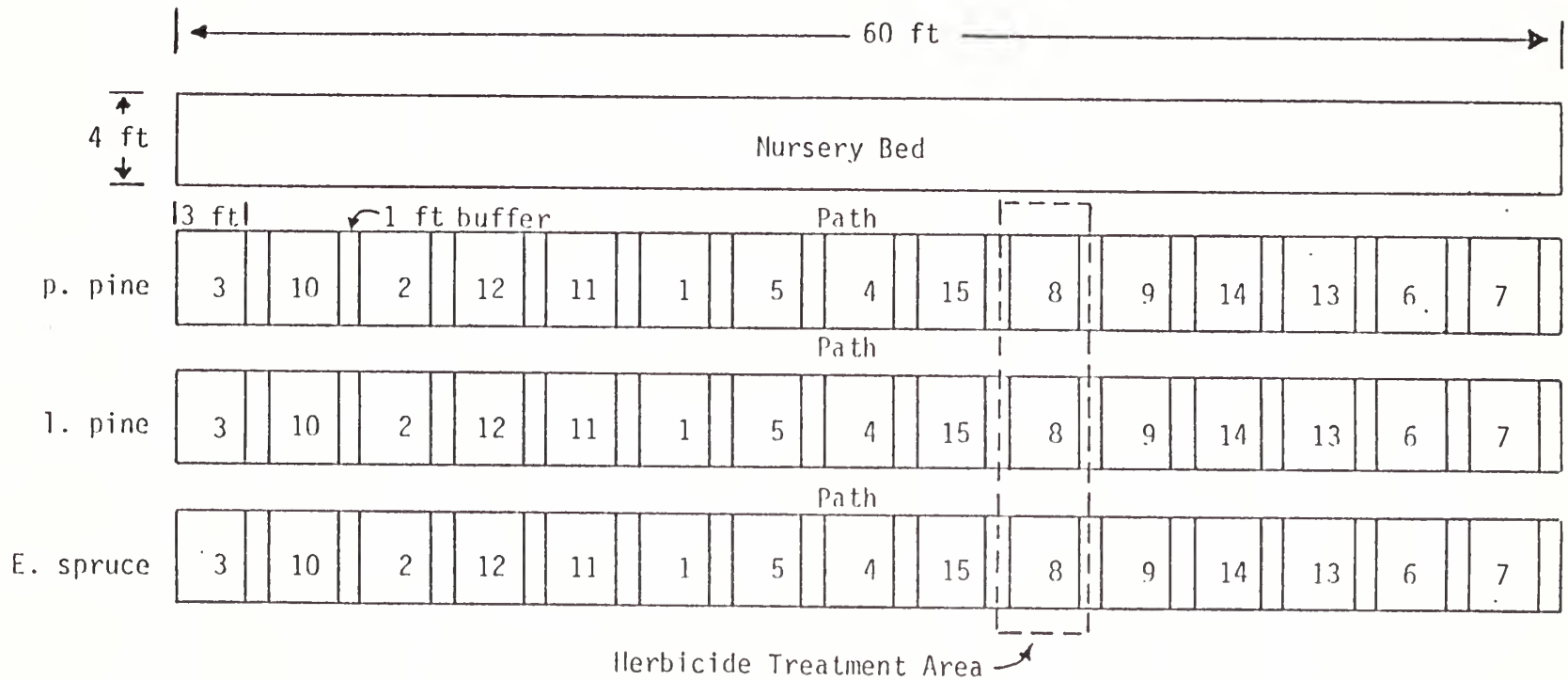

Figure 2 - The fifteen preemergence herbicide treatments were randomly applied to rectangular "herbicide treatment areas". This diagram illustrates one of 4 replications which were established contiguously in one nursery unit.

Wettable powders (WP) and emulsifiable concentrates (EC) were applied as liquids in a carrier base of 100 gallons of water/acre. Hand sprayers were used to apply these chemicals by a standard technique to insure even coverage. Granular chemicals (G) were applied manually.

All herbicides were evaluated for phytotoxicity using two indices: seedling emergence counts and visual ratings of seedling vigor. Seedling emergence was measured by counting the number of emerged seedlings in three one-foot sections of seed row; these values were then averaged to yield an estimate of seedlings per foot. All seedlings within the herbicide treatment area were rated for visual phytotoxic symptoms based on the relative scale given in Appendix I.

Weed control effectiveness was evaluated on the entire treatment area using the rating scheme in Appendix I. Weed diversity ratings were obtained by identifying all weed species present within the treatment area. Weed biomass was calculated by harvesting all weeds within two 1/50,000-acre circular plots. Green weights were taken for each sample; oven-dry weights were obtained after drying at 80° C until weight stabilized.

Contact herbicides

Three chemicals were applied to already emerged tree seedlings as contact herbicides: Lorox was used at 0.5, 4.0, and 8.0 lbs./acre, Modown was applied at 2.0 and 4.0 lb. rates, and two Round-up treatments of 0.5 and 1.0 lb./acre were included. All of these herbicides were hand-sprayed on sections of seedbed that contained seedlings ranging from 1-3 years of age; all three tree species were treated. Lorox and Modown were applied uniformly over the seedbed, whereas Round-up was only sprayed after the seedlings were protected with split sections of plastic pipe. Lorox was applied only as a dormant spray, after the period of active tree shoot growth.

All contact herbicides were visually rated for phytotoxicity and weed control on short sections of seedbed using the criteria in Appendix I.

RESULTS AND DISCUSSION

During the 1976 growing season all weed species were collected and identified. A presence list in relative order of abundance is given in Appendix II.

Preemergence herbicides

There were no instances of severe or even moderate phytotoxicity during the premergence herbicide trials on any of the three tree species. With a 10.0 rating as no visible phytotoxicity, all treatments averaged over 8.0 (Table 2). The most serious phytotoxic symptom recorded during the growing season was a slight chlorosis of the primary needles as reflected in the 8-9 ratings. This was probably due to low soil fertility rather than any adverse chemical effect caused by the herbicides. In general, the post-emergence applications had the lower ratings since these were taken later in the season when the chlorotic symptoms were more apparent.

The seedling emergence measure of phytotoxicity varied more between tree species than between different herbicide treatments (Table 2). Ponderosa pine seedling densities were greater than for either lodgepole pine or Engelmann spruce, but this is probably a reflection of sowing practices and seed quality. Engelmann spruce had the most variable seedling counts, ranging from as few as 5 to as many as 17 seedlings/lineal foot. A one-tailed paired t-test was performed on these data comparing seedling counts of individual herbicide treatments against the control values. The only significant difference at the 0.05 level was for lodgepole pine in the Modown post-seeding treatment (Table 2). This finding is perplexing, however, because the Modown post-seeding treatment also had the highest seedling density for ponderosa pine, actually higher than the control treatment. Additional tests are warranted to investigate these findings.

Weed control efficiency was extremely variable between herbicide treatments, although several chemicals gave excellent weed control. Because of an abundance of weed seeds from the previous season, the efficiency of the herbicides was obvious; if the preemergence herbicide was effective, few weeds emerged in the treatment area (Figure 3).

Post-emergence application treatments were not rated for weed control because this mid-season application was not effective against weeds which were already established. Purslane has the ability to vegetatively propagate itself and many new purslane plants probably developed from plant parts remaining after the preapplication weeding. None of the post-emergence herbicides gave good weed control when applied alone but could prove an effective supplement to herbicides applied earlier in the season.

TABLE 2 Phytotoxicity and Weed Control efficiency values for preemergence herbicide treatments

TREATMENT No.	CHEMICAL	TYPE OF APPLICATION	TREE SPECIES	PHYTOTOXICITY		WEED CONTROL EFFICIENCY		
				PHYTOTOXICITY RATING	SEEDLING EMERGENCE (No.per lineal foot)	WEED CONTROL RATING	WEED SPECIES (No.)	WEED BIOMASS (green wt.)
1	Oymid	Pre-seeding Incorporation	LPP	10.0	11.8	2.8	5.0	145.2
			ES	10.0	12.9			
			PP	10.0	21.3			
2	Dymid	Post-seeding	LPP	10.0	16.7	1.8	5.5	171.7
			ES	10.0	17.4			
			PP	10.0	20.7			
3	Dymid	Post-emergence	LPP	8.5	-	-	-	-
			ES	9.5				
			PP	9.5				
4	Treflan	Pre-seeding Incorporation	LPP	9.8	12.1	6.2	3.5	84.7
			ES	9.5	6.7			
			PP	10.0	18.9			
5	Dacthal	Post-seeding	LPP	9.8	10.2	8.0	4.5	0.7
			ES	10.0	13.1			
			PP	10.0	21.4			
6	Dacthal	Post-emergence	LPP	9.2	-	-	-	-
			ES	9.2				
			PP	10.0				
7	Ornamental Weeder	Post-emergence	LPP	10.0	-	-	-	-
			ES	10.0				
			PP	10.0				
8	Amex-820	Pre-seeding Incorporation	LPP	9.8	9.9	6.2	3.8	77.1
			ES	10.0	13.4			
			PP	10.0	19.7			
9	Amex-820	Post-seeding	LPP	10.0	12.1	8.5	4.5	0.5
			ES	10.0	12.7			
			PP	10.0	20.0			
10	Amex-820	Post-emergence	LPP	10.0	-	-	-	-
			ES	9.8				
			PP	10.0				
11	Devrinol	Post-seeding	LPP	10.0	8.9	8.2	3.5	0.6
			ES	10.0	9.9			
			PP	10.0	20.8			
12	Devrinol	Post-emergence	LPP	10.0	-	-	-	-
			ES	9.5				
			PP	10.0				
13	Modown	Post-seeding	LPP	9.8	8.2*	9.8	2.2	0.0
			ES	9.5	5.6			
			PP	10.0	27.0			
14	Modown	Post-emergence	LPP	9.8	-	-	-	-
			ES	9.2				
			PP	10.0				
15	Control	-----	LPP	10.0	15.2	0.0	6.2	177.0
			ES	10.0	10.8			
			PP	10.0	24.6			

* Statistically significant at the 0.05 level

Figure 3 - The weed-free rectangular shape of the herbicide treatment area illustrates the effectiveness of some pre-emergence herbicides (Modown in this instance).

The three unregistered agricultural herbicides had the highest weed control ratings (Table 2). Modown had an almost perfect rating of 9.8 on a 10-point scale; whereas, Devrinol and Amex-820 (post-seeding) had high ratings of 8.2 and 8.5, respectively. Dacthal with an 8.0 was the only herbicide currently registered for tree crops that had a comparable rating. Treflan and Amex-820 (pre-seeding incorporation) had intermediate weed control ratings. Dymid, in either the pre-seeding incorporation or post-seeding treatments, had very poor ratings of 2.8 to 1.8.

The weed diversity ratings did not prove to be especially helpful in distinguishing between the various herbicides (Table 2). Modown allowed the fewest weed species within the treatment areas compared to Dymid, which was essentially no different from the control. The number of weed species is not a sensitive indicator of the weed problem at Mt. Sopris Tree Nursery, however, because one weed, purslane, comprised over 75% of the weeds collected during this project.

The weed biomass values show extreme differences between the various herbicide treatments, ranging from 0.0 to 177.0 grams (Table 2). These values are reported in green weight. The oven-dry weights were inconsistent due to the variable amounts of water in the different weed species. Again the new herbicides, Modown, Devrinol, and Amex-820 (post-seeding), had the most favorable ratings, which were all less than 1 gram. Dacthal had the lowest weed weight of the nursery chemicals currently in use, with a value of 0.7 g. Both Dymid treatments had values amost as high as the control and significantly greater than any of the other preemergence herbicides.

Integrating all three indices of weed control efficiency gives Modown the best overall rating. Devrinol and Amex-820 (post-seeding) also produced excellent results. Dacthal was the only herbicide currently registered for tree nurseries that gave good weed control. Based on these encouraging initial results, larger scale tests are warranted to determine proper application rates and schedules.

Chemical registration from the Environmental Protection Agency (EPA) has been applied for by the Forest Nursery Weed Control Cooperative 2/ for bifenox (Modown), butralin (Amex-820) and naproamide (Devrinol). The results of our tests should supplement the data base for these registration applications.

One interesting result of these tests was the very poor performance of Dymid, which was the preemergence herbicide last used at Mt. Sopris Tree Nursery. It is possible that weeds, especially purslane, have become resistant to Dymid, and therefore, this chemical is no longer effective. This hypothesis is supported by field observations; weeds in the Dymid treatment areas appeared to be only stunted, but soon recovered and overran the plots.

Contact herbicides

Phytotoxicity and weed control ratings for the three contact herbicides varied between individual chemicals and rates of application.

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[2]Gjerstand, D. H. and D. B. South. 1975. Annual Report of the Cooperative Forest Nursery Weed Control Project. Dept. of Forestry, Auburn University, 39 pages.

Lorox - The phytotoxic effects of Lorox varied with seedling age and application rate. First-year seedlings (1-0) were not harmed at the 0.5 lb./acre rate but were severely burned at the 4.0 lb. rate (Table 3). Older seedlings (2-0, 3-0) were not visibly damaged by the Lorox applications at the 4 lb. rate although acute leaf scorch and some seedling mortality resulted from the 8 lb. applications. It should be noted that all applications were applied as a dormant spray after the period of active tree seedling growth; damage could still occur if the herbicide contacted succulent young shoots.

Weed control effectiveness of Lorox varied directly with application rate; weed eradication was complete at the 8 lb. rate (Table 3). Weed damage was directly related to the size of the weed plants in the Lorox treatments. Smaller weeds were almost completely eradicated at the average application rate of 4 lb./acre, whereas larger plants suffered only varying degrees of foliar necrosis. Purslane is a relatively small weed and was controlled very effectively, but weeds of larger size showed varying degrees of dieback.

Considering both the phytotoxicity and weed control results, Lorox appears to be a safe, effective contact herbicide when applied to older seedlings as a dormant spray at the 4 lb./acre rate (Figure 4).

Figure 4 - Lorox proved to be an effective contact herbicide when applied as a dormant spray to older conifer seedlings.

TABLE 3 PHYTOTOXICITY AND WEED CONTROL RATINGS FOR CONTACT HERBICIDES APPLIED AT MT. SOPRIS TREE NURSERY

Chemical	Formulation	Application Rate (actual-lbs/acre)	Tree spp.	Phytotoxicity Rating[1] on Seedlings of Various Ages 1-0	2-0	3-0	Weed Effectiveness Rating[1]
Linuron	Lorox WP 50	0.5	LPP	10	-	-	2
			ES	10	-	-	2
			PP	10	-	-	2
		4.0	LPP	2	9	-	8
			ES	0	9	9	8
			PP	4	9	-	8
		8.0	LPP	-	3	-	10
			ES	-	3	-	10
			PP	-	3	-	10
Bifenox	Modown 2EC	2.0	LPP	10	-	-	8
			ES	10	-	-	8
			PP	10	-	-	8
		4.0	LPP	9	-	-	6
			ES	9	-	-	6
			PP	10	-	-	6
Glyphosate	Round-up 3EC[2]	0.5	LPP	10	-	-	1
			ES	10	-	-	1
			PP	10	-	-	1
		1.0	LPP	10	-	-	2
			ES	10	-	-	2
			PP	10	-	-	2

1/ Rating systems are defined in Appendix I.

2/ Round-up was applied with plastic protectors over the tree seedlings due to its nonspecific chemical nature.

Modown - Modown was applied exclusively to 1-0 stock and was found to have no obvious phytotoxic effects while giving quite good weed control (Figure 5A-5B). There appeared to be an inverse relationship between herbicide rate and weed control effectiveness (Table 3). Actually, the two treatments were applied at different times during the growing season, the 2 lb. application about a month earlier than the 4 lb. treatment. Field observations indicate that the growth stage of the weed has an important influence on herbicide efficacy. The earlier Modown application was probably more effective because the weed plants were still small and succulent compared to the larger, more resistant weeds found later in the growing season. Larger weeds also tend to shade each other, which restricts good dispersal of the herbicide. Application at a 3 lb. average rate should be tested early in the growing season.

Figure 5A - Young ponderosa pine seedlings were under severe competition from weeds, especially purslane, prior to application of Modown as a contact herbicide.

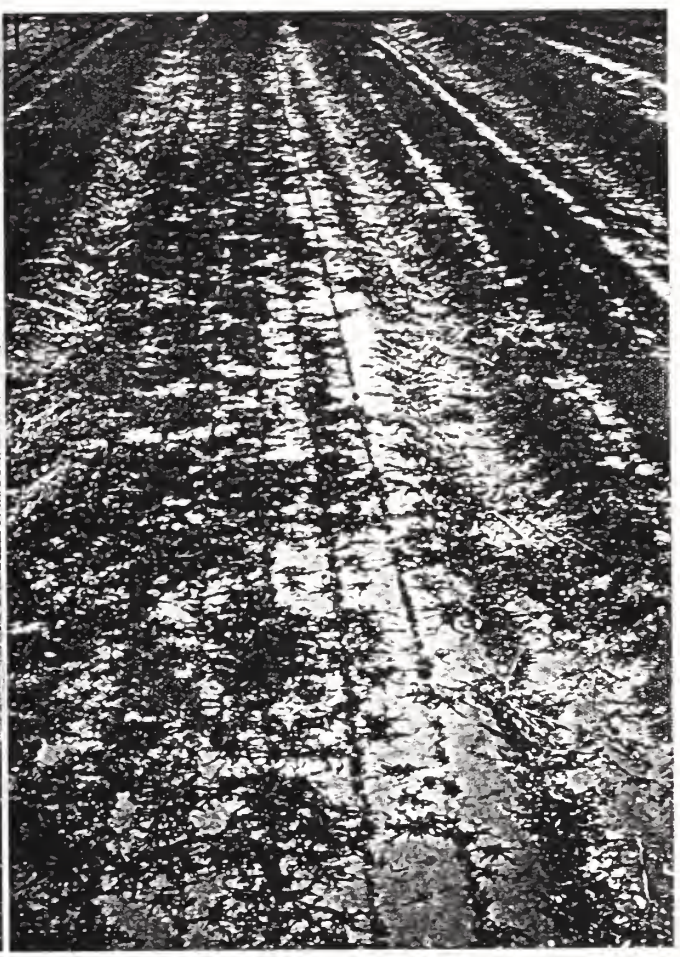

Figure 5B - The early season application of Modown gave good weed control with no obvious phytotoxic side effects.

Some weeds were apparently more resistant than others to the Modown contact applications. Purslane was most sensitive to this herbicide, while several grass species showed almost no effect; other common weeds such as sheperdspurse and dandelion had minor leaf scorch. These initial results support additional testing of this chemical as a selective contact herbicide.

Round-up - The few tests of Round-up were generally inconclusive (Table 3). The low phytotoxicity ratings are misleading because the tree seedlings were protected during the herbicide applications, and the poor weed control ratings are no doubt a function of the relatively low application rates. It is possible that higher rates would be more effective, but the logistics of covering the seedlings before application would negate the wide-spread use of Round-up in nursery beds.

CONCLUSIONS AND RECOMMENDATIONS

Overall, these field evaluations of preemergence and contact herbicides have revealed some promising new chemicals for use in forest nurseries. These results must be regarded as preliminary, however, and additional large-scale tests are required.

Preemergence herbicides

1. Three new agricultural chemicals produced the best results compared to herbicides currently registered for tree nursery use. Modown, Devrinol, and Amex-820 gave excellent weed control with no obvious phytotoxicity. Dacthal was the only currently registered chemical that produced similar results.

2. Until EPA registration is obtained for these new herbicides, Dacthal should be applied at the 14 lb. (actual)/acre rate for preemergence weed control in the nursery.

3. Additional large-scale tests should be conducted using these new chemicals to determine the minimum effective dosages and other technical aspects of their application.

4. The post-seeding herbicide applications were much more effective in controlling weeds than were the post-emergence applications. Although post-emergence applications were ineffective when used alone, this type of herbicide treatment should be tested in conjunction with post-seeding applications as a means of extending weed control throughout the growing season.

Contact herbicides

1. Preliminary tests indicated that Lorox has potential as a contact herbicide when applied to older seedlings during periods of inactive tree seedling shoot growth. Additional tests are required to determine proper rates and timing of application.

2. The use of Modown as a contact herbicide should be further investigated. Additional tests should emphasize its use on first-year (1-0) seedlings, and determine minimum effective dosages, timing of application, and toxicity on various weed species.

3. Additional tests of Round-up for use in nursery beds are not recommended because of the tedious labor involved in protecting seedlings during herbicide application.

PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.

Appendix I

Weed Control Efficiency and Phytotoxicity Rating System 1/

Rating	Weed Control	Phytotoxicity
10	All weeds eliminated	No visible damage
7-9	Good to excellent control; few weeds present	Slight damage; seedlings will recover & make near normal growth
4-6	Moderate control	Moderate damage; few seedlings will die but some will show chemical effects & reduced growth
1-3	Poor control; some reduction in weeds	Severe damage; many seedlings will die and other will be discolored & stunted
0	No control	All seedlings dead

1/ Adapted from Anderson, H. W. 1973. A system for evaluating effective weed control in forest nurseries. Tree Planter's Notes 61:19-23.

Appendix II

Weed Species Present in the Mt. Sopris Nursery

(listed in relative order of abundance)

Identified in test plots

1. Common purslane, *Portulaca oleracea* L.
2. Shepherdspurse, *Capsella bursa - pastoris* (L.) Medic.
3. Redroot pigweed, *Amaranthus retroflexus* L.
4. Dandelion, *Taraxacum officinale* Weber
5. Kochia, *Kochia scoparia* (L.) Roth
6. Filaree, *Erodium cicutarium* (L.) L'Her. ex Ait.
7. Russian thistle, *Salsola kali* var. *tenuifolia* Tausch
8. Prickly lettuce, *Lactuca serriola* L.
9. Grasses, several spp.
10. Clovers, *Trifolium* spp.
11. Common mallow, *Malva neglecta* Wallr.

Found outside test plots

12. Stickseed forget-me-not, *Hackelia floribunda* (Lehm.) Johnston
13. Common mullein, *Verbascum thapsus* L.
14. Ground cherry, *Solanum nigrum* L.
15. Willow, *Salix* spp.

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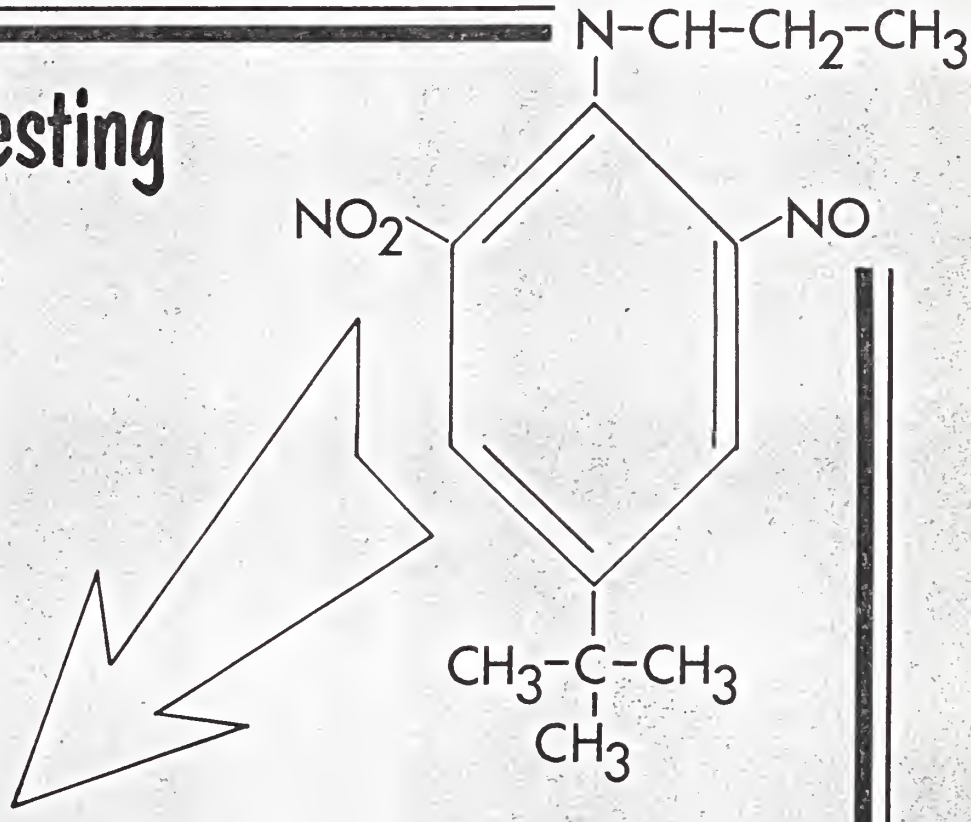

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